The Microwave Limb Sounding Technique

Characteristics and Capabilities (for ozone data)

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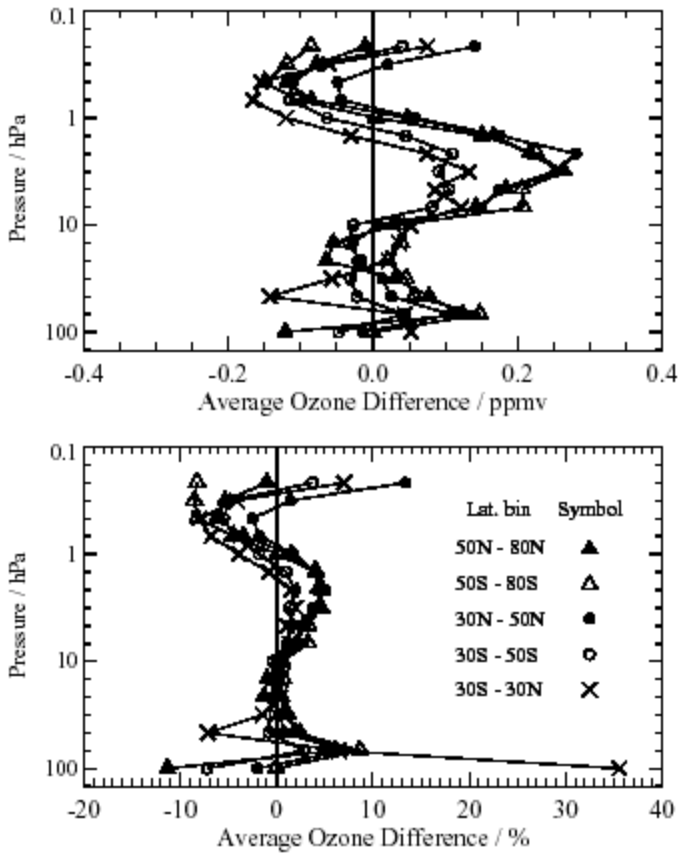
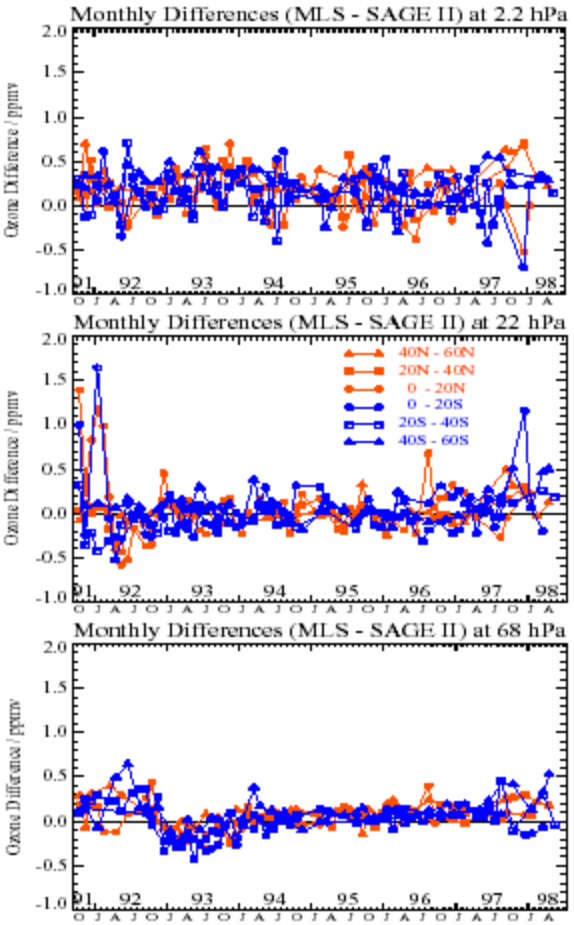
(Viewgraphs presented thanks to Derek Cunnold)

The Microwave Limb Sounding Technique

- Measures microwave (at mm and sub-mm wavelengths) thermal emission from the atmospheric limb (as antenna scans vertically)
- Accurate spectroscopic database, small temperature dependence
- Relatively insensitive (vs shorter wavelengths) to aerosols and ice clouds
- Can achieve complete global coverage, day and night, on a daily basis
- Capabilities demonstrated by UARS MLS
  - Precision (single profile) of 3% (at best, in mid-stratosphere)
  - Accuracy (syst. uncertainty) of < 6 % for pressures less than 50 hPa
  - Excellent stability for radiometric calibration (<0.01%/yr, based on space radiance stability from 1991-1997)
  - Other instrumental effects also believed to have negligible impact on long-term stability (see SPARC/WMO Ozone Report, May 1998), but interruptions caused by scanning mechanism degradation were an issue for UMLS, not designed for "very long-term" [should be better on EOS MLS]
  - Expect less than 0.1 to 0.2 %/yr effect on ozone trend detectability
  - This stability has been verified by comparisons versus SAGE II ozone data (Cunnold et al. [*JGR, 2000*]; Livesey et al. [*JGR, 2003, in press*]). Poorer performance and sensitivity was evident in LS (P> 50 hPa), tropics especially (continuum emission + cloud and other effects).
  - EOS MLS will give LS/UT ozone (UARS MLS was not optimized for this).

The Microwave Limb Sounding Technique: Comparisons vs SAGE II data



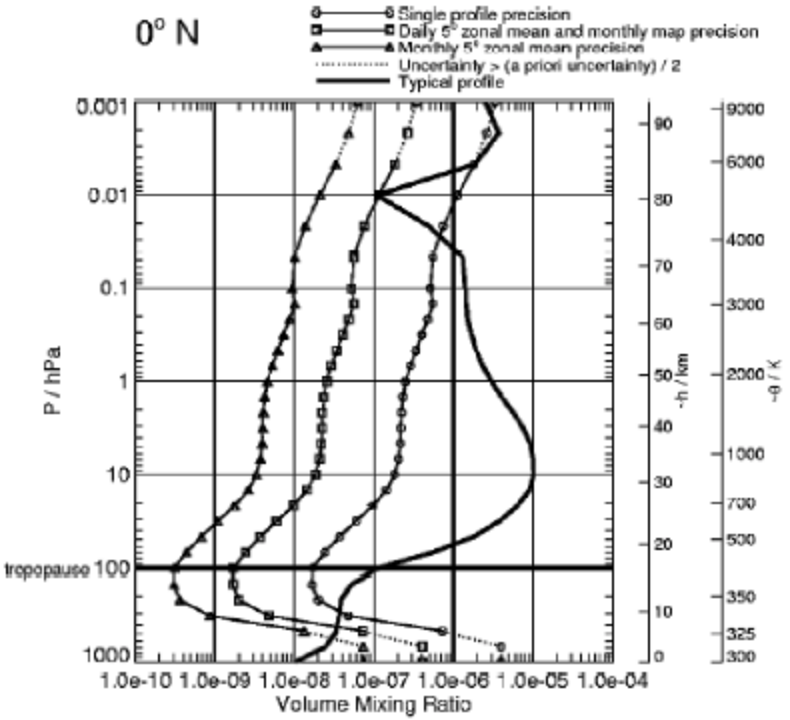


Average ozone differences (UARS MLS – SAGE) for 1995-1996 for different latitude regions (MLS V5 and SAGE V6.1 data). [*Livesey et al., JGR, 2003, in press – also shows other comparisons*]

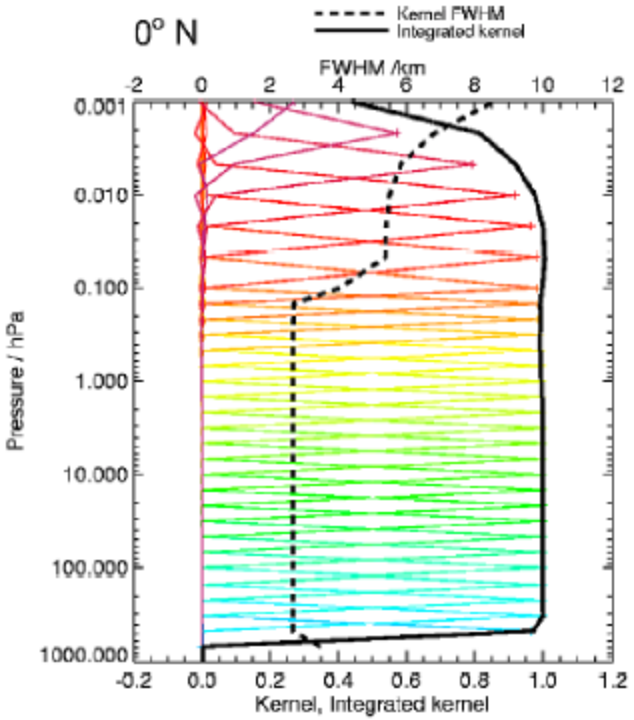
Time series of monthly average O_3 differences (MLS – SAGE) at different pressures; SAGE data have been (at least partially) screened for the effects of Mt. Pinatubo aerosol.

The Microwave Limb Sounding Technique: Future Datasets

EOS MLS: averaging kernels, vertical resolution, precision



Precision estimates for EOS MLS versus typical profile (tropics).



Averaging kernels (in color), giving vertical resolution estimate (as FWHM, dashed line) of ~2.5 km. The MLS team also intends to produce retrievals with twice as fine a resolution (in the LS/UT).

Figs. from ATBD-MLS-04, revision 1.3 (Filipiak et al., 2003)

The Microwave Limb Sounding Technique: Future Datasets

> **The EOS MLS Instrument**

- To be launched on the Aura satellite, early 2004
- Much better sensitivity to ozone than UARS MLS (larger bandwidth, better signal-to-noise, more lines), better along-track coverage (~ 170 km spacing, ~3500 profiles/day vs ~1300 for UARS MLS), no "yaw cycles."
  In particular, expect single profile precision of ~10% within 3 km above tropopause, and of < 20 ppbv within 3 km below tropical tropopause (for comparison, UARS MLS precision in LS ~ 0.4 ppmv).
  For monthly 5° zonal means, will get precision of < 1% throughout stratosphere, and < 0.3 ppbv within 3 km below tropical tropopause.
- Systematic uncertainties not fully characterized yet (post-launch analyses needed as well), but expect as good as UARS MLS and to lower altitude; degradation by (some) clouds expected for LS/UT, still under study.

> **Future trends in ozone profiles**

- In general, model expectations for next decade (or two) are for substantially smaller rates of ozone decrease (a "flattening out").
- The microwave technique should be able to determine whether the significant downward trends (5%/decade) are abating (or have abated), and the eventual rate of increase (later on) [more important, and easier, than determining the exact value of a small rate of change during the turn-around period]. Of course, connecting to prior long-term data would be needed.